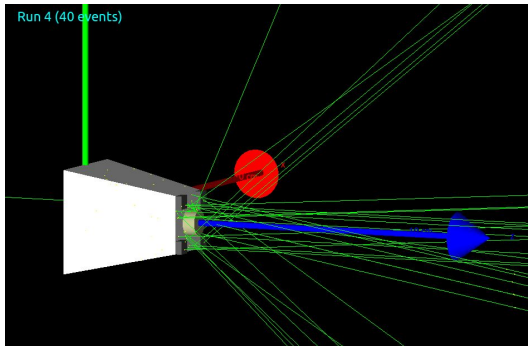
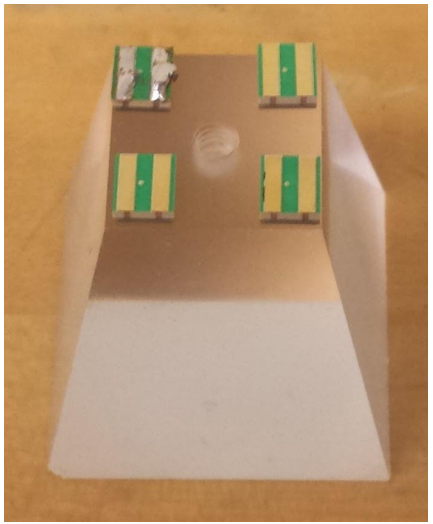



# Geant4 Study of Lightguide Efficiency/ Uniformity



Michael Phipps

# Method

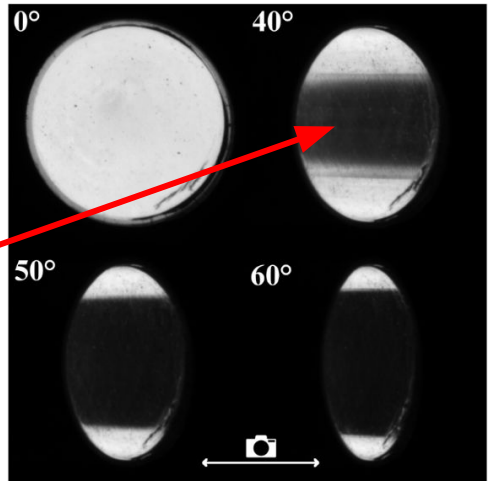
- Geant4 scan using 2.75 eV photons
- Photons emitted from inner edge of wide end of lightguide
- Angular distribution: see slide 3
- Scan proceeds in even steps with 1k events per position and a 16x16 sample matrix
- Total efficiency defined as average hits/samples across entire scan
- Hit defined as any event with a photon entering an sipm. Hit receives a score of 1, all other events receive a 0
- Lightguide built with acrylic and refractive index of 1.49, absorption length of 26 m and reflectivity of 96% (Fresnel losses with polished lightguide). Boundary between lightguide and air defined as dielectric-dielectric
- Screw built with acrylic and given same optical properties as lightguide with coarse unpolished interface between the two
- Four 3x3 mm sipms flush against end of lightguide

# Angular Distribution

- Particle gun placed along bottom edge of lightguide with angular emittance set using distribution below
- German Master's student did angular CCD scan and Geant4 simulations on emittance angles of single/multiclad lightguides, scintillating fibers and WLS
- Scanned Theta angle from 0-90 deg; intensity weighted at each point by the 2pi azimuthal solid angle
- http://web.physik.rwth-aachen.de/~hebbeker/theses/nieswand_master.pdf
- Numerical aperture of our fibers: 0.555 -> Max angle for meridional rays: $\sin^{-1}(NA) = 33.7^{o}$
- Distribution not exact for our fibers but approximate to first order

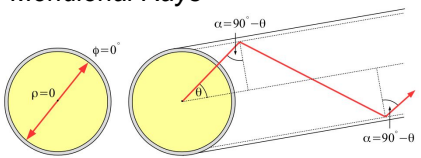
Beyond numerical aperture, only skew rays remain.

Higher angles -> rays closer to cladding

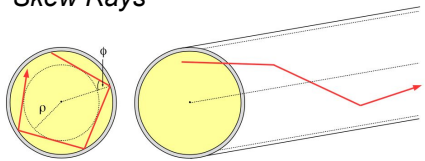


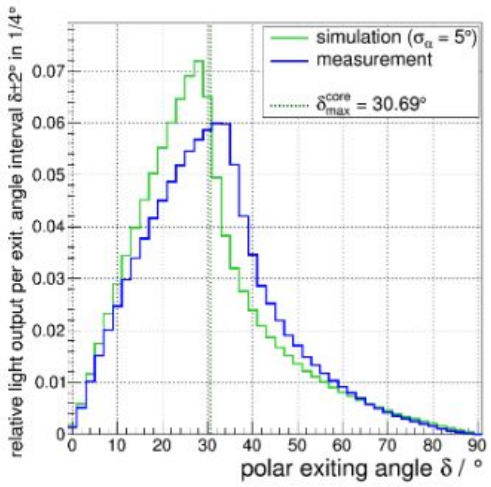

**2 Types of Rays in Fibers:**

*Meridional Rays*

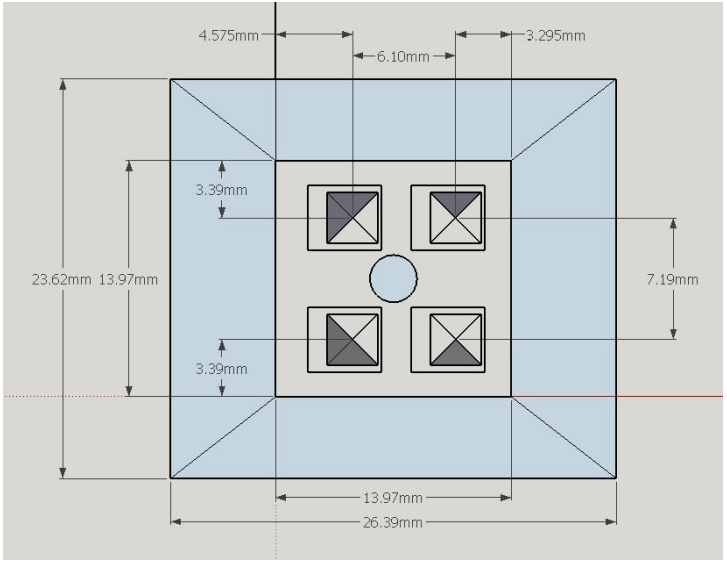



*Skew Rays*

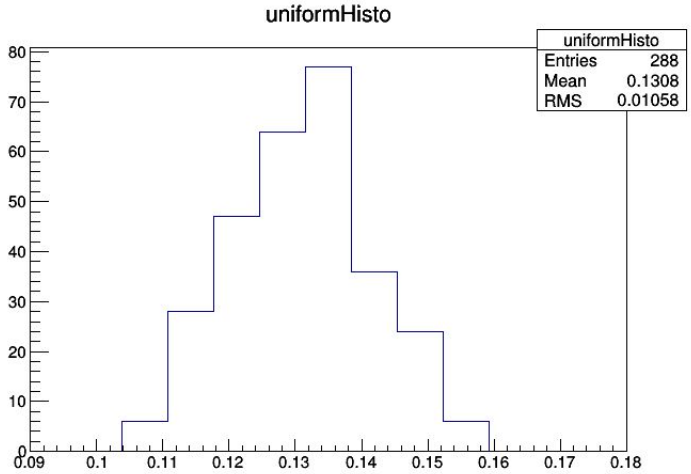


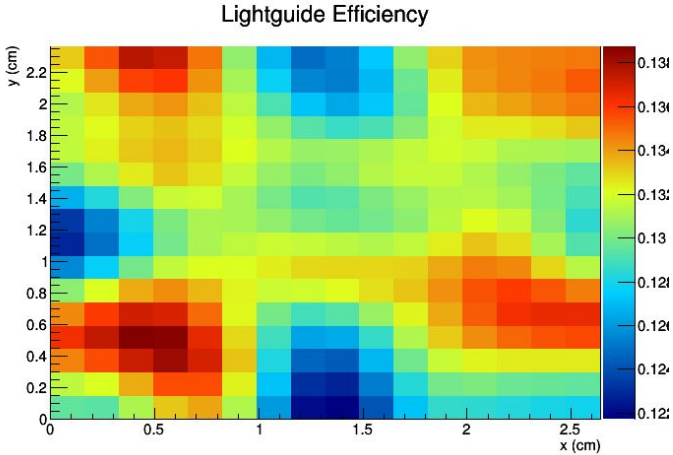



# Rectangular array (-0.64 mm offset not included)

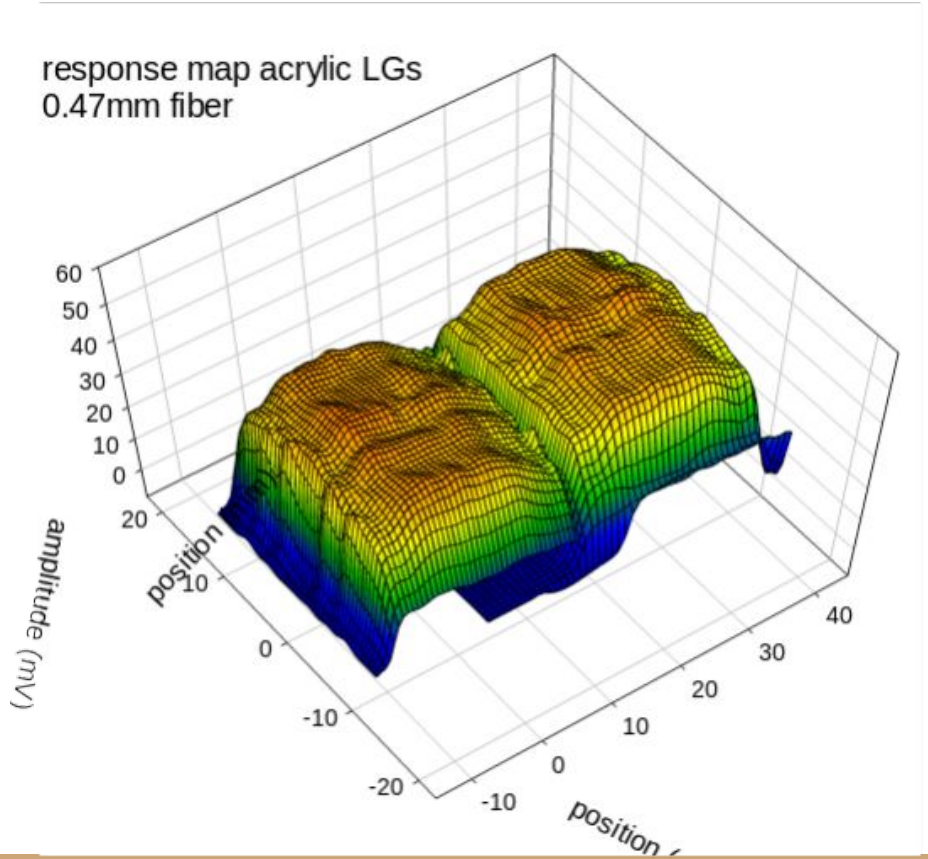



- **Currrent sPHENIX LG**
- Avg Efficiency: 13.08%
- RMS: 0.01058
- Range: 0.055
- Max Efficiency: 0.159
- Min Efficiency: 0.104
- Geometric Acceptance:



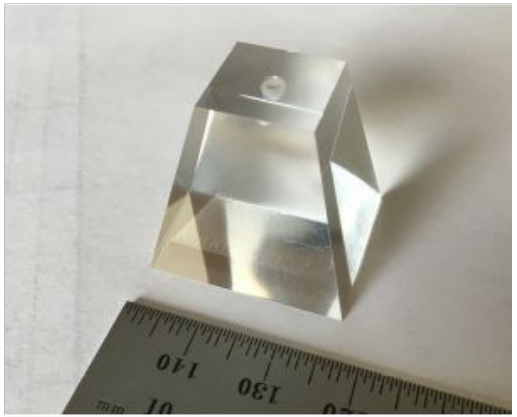
# Sean's Measured Results



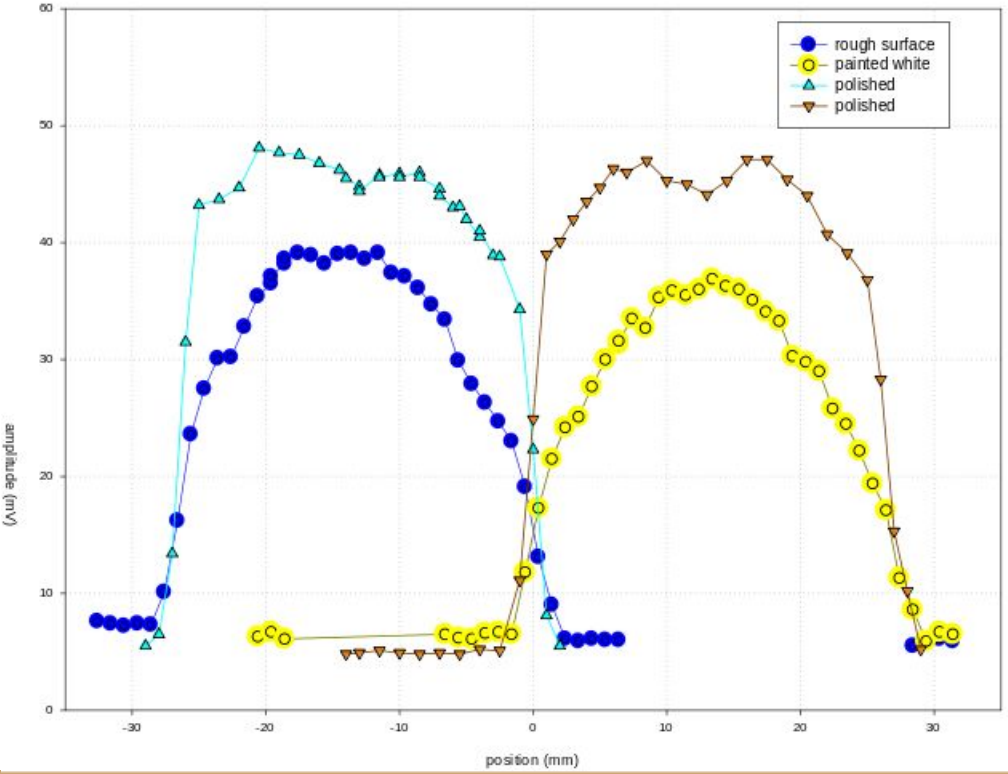

sPHENIX prototype 2 LG

Polished

Maximum efficiency = 0.133



# Sean's Measured Results




Peak Corresponds to efficiency ~0.13

Surface treatments
Prototype-2 LG